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NEW AND RENAMED SUBSPECIES OF CROTALUS CONFLUENTUS SAY, WITH REMARKS ON RELATED SPECIES

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INTRODUCTION

Somewhat over two years ago I became interested in the form of rattlesnake described by Kennicott in 1861 as *Caudisona scutulata,* or, according to modern terminology, *Crotalus scutulatus.* It has appeared to me from experience with a considerable series of live specimens that the present customary classification of this form as a phase of *Crotalus atrox* or, less often, as *C. oreganus* or *C. confluentus* is inaccurate. With the results of this investigation I hope to deal in a subsequent report; I would say at this time that I have reached the conclusion that *C. scutulatus* is a valid species which, although more closely related to the *confluentus* than the *atrox* group, apparently intergrades with neither. Some of the evidence upon which this conclusion is based is cited in the final discussion in this paper, since the relationships of various closely related species cannot be outlined without defining *scutulatus.*

Of course in the use of the term *C. scutulatus* I am not referring at random to any rattlesnake with paired scutes between the supralabials, but rather to the snake that Kennicott described, which has other characteristics as definitely distinguishing it from its nearest relatives as this character from which it derives its name. My conclusions are based on scale counts of 157 specimens of *C. scutulatus,* of which 88 are recent acquisitions in my own collection. In addition I have seen not less than 100 other specimens alive. Availability of new and adequate material (at least from some areas) rather than a new angle of approach has, I think, permitted a definite determination on this *scutulatus* problem, which because it has heretofore involved the confusion of specimens of a single species with two other valid species (*atrox* and *confluentus*) has led to perplexity in all of these.

In the course of this investigation as to the status of *scutulatus* it was necessary to examine a considerable series of the various species and subspecies of the *atrox* and *confluentus* groups. Each new accession of material has led to new problems and new lines of investigation in an ever-widening geographical range. Altogether, scale counts and comparative measurements were made on well over a thousand specimens of rattlesnakes from most of the western states and northern Mexico, and in the course of these excursions I chanced upon two apparently unnamed subspecies of *C. confluentus* and two, which, while well known, require new names. It is with these subspecies that the present paper deals.

THE RATTLESNAKE OF THE GREAT BASIN

The Great Basin rattlesnake has long been recognized as a subspecies of *Crotalus confluentus* (or *Crotalus oreganus*) yet even today it has not a valid name. The following comments on the designations heretofore proposed will clarify the situation.

Neither the name *C. oreganus,* Holbrook, 1840, nor *C. lucifer,* Baird and Girard, 1852, is applicable to this form, since both refer to the snake of the Pacific coast rather than the plateau region. Through the courtesy of Dr. Witmer Stone of the Academy of Natural Sciences of Philadelphia, I have lately seen a photograph of Holbrook's type specimen, thus corroborating the description and Holbrook's figure. It is evidently of the coast form. Also there is reason to believe that this specimen was collected between Walla Walla, Washington, and the Pacific Ocean; and since the coast form occurs at least as far east as Walla Walla (*vide* USNM 10914), we may conclude that *Crotalus confluentus oreganus* is the proper designation of this subspecies,[1] and that this name is not applicable to the Great Basin rattler. Similarly it is known that *C. lucifer* refers to the coast form, both by reason of the route of the collecting party (The Wilkes' Exploring Expedition) and the description, although the type locality is indefinite, being "Oregon and California," and both subspecies inhabit these states.

The next name possibly applicable is *Crotalus lecontei* Hallowell, 1852. Cope in some of his later papers referred to the Great Basin rattler as *Crotalus confluentus lecontei,* stating: "This form is the *C. confluentus* of the Great Basin."[2] But more recently Stejneger has

1 I am indebted to Dr. T. S. Palmer, Senior Biologist, U. S. Bureau of Biological Survey, for reference to "A Journey to the Columbia River, and a Visit to the Sandwich Islands, Chili, etc." by J. K. Townshend, 1840. This described the expedition to which Nuttall was attached when the type specimen was collected. The type locality is given as "the Banks of the Oregon or Columbia River." The Townshend-Nuttall party struck the Columbia at the junction with the Walla Walla River.

2 1900. Report U.S.N.M. for 1898, p. 1175.

shown[3] that this name is invalid, the type locality being beyond the range of the present subspecies.

Van Denburgh states:[4] "The snakes of Utah, Nevada and eastern California may perhaps deserve similar treatment (*i. e.,* be regarded as a subspecies) since their color pattern is usually different from that of typical *C. oreganus.*" But he does not suggest a new name.

Do Amaral[5] most recently has renamed this subspecies *Crotalus confluentus kellyi,* but this name, I regret to state, is likewise invalid, since the subspecies under consideration is confused with the troublesome *C. scutulatus* and both the type and paratype of *kellyi* belong to the latter species. These two specimens are Nos. 194 and 195 in my own collection; they are from Needles, California, beyond the range of the Great Basin rattler. It is with regret that I find the name *kellyi* inapplic- to this subspecies, since Dr. Howard A. Kelly, for whom it was named, was largely instrumental in causing me to become interested in herpetological literature and I am indebted to him for many favors.

The Great Basin rattler differs consistently from *scutulatus* in characteristics of form, color, markings and scutellation. Of these I will at this time point out two of the most definite, as indicated by the specimens at hand:[6]

A. SCALES BETWEEN NASALS IN CONTACT WITH ROSTRAL (INTERNASALS)

	2	3	4	5	6
Great Basin	6	38	111	8	4
Scutulatus	148	1	1[7]	0	0

B. MINIMUM SCALE ROWS BETWEEN SUPRAOCULARS

	1	2	3	4	5	6	7	8	9	10
Great Basin	0	0	7	16	37	44	37	21	5	1
Scutulatus	1	140	11	0	0	0	0	0	0	0

This, in spite of some overlapping, seems to me quite significant in a genus such as *Crotalus,* in which there is much variation of scutellation

[3] In do Amaral, 1929. Bull. Antivenin Instit. of Amer., Vol. II, No. 4, p. 87.

[4] 1922. Occ. Papers Calif. Acad. Sci., X, p. 937.

[5] 1929. Bull. Antivenin Instit. of Amer., Vol. II, No. 4, p. 86.

[6] In this and the following tables the numbers in the body of the tables indicate the number of specimens falling into each classification. Occasionally there are two counts per specimen. The variation in totals between tables is often due to the illegibility of certain characters in some specimens.

[7] May be due to abrasion and regrowth in captivity.

within a species owing to the tendency of almost any scale occasionally to be split or fused with a neighbor. If we deduce from the above tables that *scutulatus* should have two internasals and the Great Basin form three or more; and again that *scutulatus* should have two scale rows between supraoculars, while the other form should have three or more, then not a single specimen out of some 317 of both forms falls into the other's territory in both characteristics. One Great Basin rattler (LMK 2280 from Zion Park, Utah) has two internasals and three scale rows between supraoculars. The other six having three scale rows have three or more internasals. And there are other characteristics in which the two forms differ quite as definitely, as for instance in the width of the postocular light stripe, the presence of a supraocular light cross mark, etc.

So far as is now known, 150 miles of mountain and desert separate the ranges of these two forms at their nearest points. Even were they conspecific, intergradation could only be through a third subspecies.

This rattlesnake of the intermountain states, having no valid name, I therefore re-describe as

Crotalus confluentus lutosus,[8] subsp. nov.

Great Basin Rattlesnake

Plate 10, fig. 1.

Type.—No. 1814 in collection of L.M.K. Captured alive 10 miles northwest of Abraham on the road to Joy, Millard County, Utah. Altitude approximately 4650 ft. Collected May 12 ,1929, by C. B. Perkins. Paratypes (16): Nos. 1800-13, 1815-16 collected at the same time and place.

Diagnosis.—A subspecies of *Crotalus confluentus* differing from the typical form in the width of the postocular light line, which is two or three scales wide in *lutosus* and one wide in *confluentus*.[9] Likewise, *lutosus* has a higher average number of scale rows between supraoculars and a greater irregularity in blotch borders than has *confluentus*. *Lutosus* is usually drab or buff in coloration; *confluentus* is gray, green, olive, brown or red-brown.

From *oreganus*, *lutosus* differs primarily in color, the former being black, dark gray or dark brown; also in the character of the body blotches, which in *lutosus* tend toward narrow (measured longitudinally) hexagons well separated, while in *oreganus* the blotches are diamonds, circles, rectangles or hexagons proportionately wider along the body and with less relative separation. Since these two subspecies intergrade, differences of coloration and markings are

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[8] Clayey. Referring to the coloration.

[9] In the interest of brevity, I have used the term *confluentus* when the subspecies *Crotalus confluentus confluentus* is meant and *C. confluentus* to indicate the species.

more pronounced between representatives distant from the area of intergradation.

From *Crotalus scutulatus, lutosus* differs in having ordinarily three or more internasals, instead of two as in the former; in having a higher number of scale rows between supraoculars; in greater width of the postocular light line, which is rarely more than one scale wide in *scutulatus;* in color, which in *scutulatus* is yellow-green, green, olive or brown; and in the light supraocular cross bar, which, when at all discernible in *scutulatus,* is an amorphous light area, while in *lutosus* it is always present and is emphasized by contrasting, even margins.

Description of Type.—Young adult male. Length 832[10] to rattles, tail 60, ratio .072. Length of head 35.5, times contained in body length 23.4. Width of head 28. Width across supraoculars 16.2, distance between supraoculars 7.0, ratio 2.3. The head is subtriangular, depressed, and except for the supraoculars, covered with small scales. Scale rows 27-25-21,[11] keeled, except the last two rows on each side. Ventrals 183, anal entire, caudals 26, supralabials 15-15,[12] infralabials 16-17. Rostral higher than wide. Four scales in contact with rostral between prenasals, total in contact 8, including both prenasals. Prenasals in contact with first supralabial. Scales on top of head along canthus rostralis 3-3, the posterior larger. Scales on head anterior to supraoculars about 30. Minimum scale rows between supraoculars 6. No supraocular sutures. Nasals 2-2; loreals 2-2, the upper small. Postnasal not in contact with upper preocular. Preoculars 2-2, post- and suboculars 5-6. Preoculars undivided vertically. Scale rows between labials and orbit 3+4, 3+3. First infralabials in contact on median line. Genials in a single pair with relatively obtuse terminal angles. Infralabials in contact with genials 3-3.

Across the supraoculars there is a light band about 1 mm. wide, evenly margined with a darker, contrasting color. A preocular light stripe about two scales wide has its upper edge carried from the lower edge of the eye to the last supralabial. There is a postocular light line two to three scales wide, which occupies rows 4 and 5 above the supralabials at the commissure. The top of the head back of the supraoculars is irregularly blotched with brown on a drab ground color.

The dorsal body pattern consists of a series (42) of roughly margined subhexagonal blotches degenerating into rings posteriorly. The blotches are brown (darker on their interior borders) on a drab background. At midbody the blotches are 2½ to 3 scales wide (along the body) by about 10 scale rows across. The interspaces approximately equal the blotches in width. On the sides a secondary series of smaller blotches of double frequency is faintly in evidence. Toward the tail, half of these merge into the main rings.

Using Ridgway's Color Standards (1912) the ground color averages "Light Drab," the blotches "Olive Brown" to "Natal Brown."

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10 These measurements were made before the specimen had been placed in alcohol to harden. All measurements in millimeters.

11 One head length behind head, at midbody and at vent.

12 Right side given first.

The ventrals are "Baryta Yellow" mottled with gray which increases caudad. The head is lighter below, although the infralabials and genials are punctated with gray.

The tail rings number eight and are approximately equal in width to the interspaces. The last two are black and have less definite outlines. The ground color of the tail is similar to that of the body, except that it is dark at the terminus.

There are seven rattles, the string tapering from the base, thus indicating probable continued body growth. The base is black. The button is missing and would probably complete the string.

Range.—This subspecies ranges over much of the plateau region from the Rockies to the Sierras, including Utah west of the 111th Meridian, northern and central Nevada, northern California east of the Sierras, southeastern Oregon and southern Idaho. Whether specimens from northeastern Oregon and central Idaho should be referred to this subspecies, as is sometimes stated, I do not know, as I have not seen sufficient material from this area to judge. Specimens from the eastern border of Washington are of the coast form, *oreganus*.

A few localities near the borders of the verified territory, which will serve roughly to define it, are given hereunder. From all of these localities, specimens have been examined.

UTAH

Cache County
  Wellsville Canyon
  Wasatch Mountains

Salt Lake County
  Fort Douglas

Wasatch County
  Wasatch Mountains

Utah County
  Provo

Sanpete County
  Maple Canyon

Garfield County
  Border of Bryce Canyon National Park, near Tropic

Washington County
  Bellevue
  St. George
  Zion National Park
  Springdale

NEVADA

White Pine County
  Snake Valley
  5½ mi. S.E. of Osceola

Nye County
  Peavine Creek, Toyabe Range

Mineral County
  Endowment Mine, Excelsior Mountains (intergrade)

CALIFORNIA

Mono County
  Lundy
  Williams Buttes

El Dorado County
  South of Lake Tahoe

CALIFORNIA (Continued)

Lassen County
  Eagle Lake
  4 mi. N.E. of Red Rock

Modoc County
  Warner Mountains
  (intergrade)

OREGON

Harney County
  Diamond

IDAHO

Canyon County
  Melba

Ada County
  15 mi. S. of Boise

Elmore County
  Regena
  Cleft

Butte County
  Big Butte
  Little Lost River

Madison County

Teton County

Within the territory thus outlined, no other rattlesnake is now known to occur except *Crotalus cerastes* in southwestern Utah and southern Nevada. But intergradation of *lutosus* with other *confluentus* subspecies probably occurs along much of the boundary; also, there may be, and probably are, some areas in which the present subspecies and others occupy the same territory without intergradation.

The maximum altitude of which I have a record is 8000 ft. (Wasatch Mountains, Cache County, Utah).

General Description and Remarks.—The following data on this subspecies are summarized from scale counts and measurements of 190 specimens.

Size, large. Scale rows at midbody usually 25 (82 percent.), occasionally 23 (4 percent.) or 27 (9 percent.), rarely 24, 26, 28 or 29 (less than one percent. of each). Scales keeled except the first, or first and second rows, on the sides. Ventrals: males, max. 194, min. 171, av. 180 (115 specimens); females, max. 194, min. 171, av. 184 (71 specimens); both sexes, average 181 (187 specimens). Anal entire. Caudals: males 18 to 29, average 23.7 (108 specimens); females 13 to 25, average 19.3 (70 specimens). The extremes above given are seldom attained, most of the males being from 21 to 26, while the females usually range from 17 to 21. The caudals are generally entire, but a few at either end of the series or in the middle may be divided. Supralabials usually 15 (41 percent.) or 16 (36 percent.), occasionally 14 (11 percent.) or 17 (9 percent.), rarely 13, 18 or 19 (less than 2 percent. of each). Infralabials usually 15 (30 percent.), 16 (38 percent.)

or 17 (22 percent.), occasionally 14 (4 percent.) or 18 (4 percent.), rarely 13 or 19 (less than one percent. of each).

The rostral is usually higher than wide. It is generally, but not invariably, in contact with the prenasals, a negative example being Univ. Mich. 59716. While the prenasal is normally in contact with the first supralabial, such contact is not infrequently prevented by the extension to the rostral of the small scales anterior to the pit. The internasals (scales in contact with the rostral between nasals, regardless of size or relative position) are usually 3 or 4, rarely 2, 5 or 6. The canthals vary from 2 to 5. The scales on the top of the head before the supraoculars are rarely less than 20 and average about 30. The minimum scale rows between supraoculars vary from 3 to 10, averaging 6.

Supraocular sutures or indentations occur in a number of specimens (26 out of 134, or 19 percent.) The tendency to division of the supraoculars is more common in the western than the eastern specimens, thus showing a definite trend toward the subspecies next described; however, even on the western border the positive specimens are not in the majority. In character the sutures vary from single pits to circular swirls or complete transverse divisions. The pits and swirls are usually close to the outer edge on each side, corresponding to the location of the raised process in *cerastes*. The nasals are 2-2. About half the specimens have two loreals, the rest one; the upper is always the smaller when present. The upper preocular is usually not in contact with the postnasal. In only one specimen is the upper preocular divided vertically in the manner so often observed in *mitchellii;* however, the upper corner at the eye is not infrequently split off, thus constituting a third small preocular. The scale rows from labials to orbit vary from 2 to 4. I have no record of a specimen with completely divided first infralabials. Usually 3 or 4 infralabials are in contact with the genials; rarely 2 or 5 .

The average ratio of the body to the head length in 95 adults (over 500 mm. in length) is 22.9,[13] max. 26.3, min. 19.4. The ratio of the length of tail to total length exclusive of rattles varies from about .060 to .083 in the males (average .070) and .045 to .065 in the females (average .053).

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[13] In utilizing head sizes for comparative purposes a moderate series must be available as some deviations, owing to drying out and other difficulties in preservation or capture, are to be expected. Where live specimens are available they should be measured immediately after killing, while still limp. Juveniles must be neglected or treated graphically, as the head size is comparatively larger in the young.

The ratio of width across the supraoculars to the space between averages 2.5 (range 2.1 to 2.9).[14].

The largest specimen examined measured 1075 mm. (44 in.). There is every reason to believe that a length of not less than 1230 mm. (4 ft.) is reached. The smallest specimen noted was 270 mm. in length.

The most conspicuous mark on the head is a light bar across the supraoculars which is always present even in adults; in this respect it differs from *oreganus* which usually loses this mark with age. This supraocular dash is bordered by dark lines, thus giving it a clear edge (a difference from the *atrox* group and *scutulatus*). The edges of the dash may be parallel or inwardly divergent (the latter form predominates in *confluentus*).

Behind the supraoculars there is an area of the ground color darkened by blotches or spots of irregular position and outline. Anterior to the neck there is usually a pair of blotches constituting an introduction to the dorsal series.

On the sides of the head are the pre- and postocular light stripes so characteristic of the rattlers. These are separated by a dark stripe about three scales wide arising at the eye and passing backward and downward, the lower edge being above the angle of the mouth. The anterior light stripe, about two scales wide, arises at the upper preocular and usually includes the last supralabial. There is often a characteristic dark spot on the labials splitting this light line at about the ninth and tenth supralabials. The posterior light stripe, 2 to 4 scales wide, arises at the upper posterior corner of the eye and passes backward to the neck, always above the supralabials. Its interior edge is often ill defined.

Below, the head is usually immaculate, except that the mental and infralabials are dark.

The ground color of the body is drab, or buff. On this there is a dorsal row of irregular brown blotches usually subhexagonal in shape. These blotches vary in number from 35 to 49 (average of 156 specimens, 40.9). The blotches are ordinarily greater in dimension across the body than longitudinally (about 10 scales to 3). Usually the interval between blotches at midbody is approximately equal to their width, but it may be less, thus approaching *oreganus*.

The blotches are generally dark brown, at least at the edges; however, in some large adults they are much faded. Rarely the blotches are

[14] 34 random specimens of *scutulatus* have an average of 3.3 (range 2.6 to 4.0).

of solid color, but generally the borders are darker; sometimes the border only is conspicuously different from the ground color. The blotch edges are irregular or serrated, but not closely following scale lines (i. e., with unicolored scales) as in *scutulatus* and *molossus*. The blotches are not bordered with a row of scales lighter than the ground color as in *oreganus* and *scutulatus,* nor by a narrow bright line as in *confluentus*. On the sides there is a secondary set of blotches faintly in evidence and often of double frequency. Toward the tail the dorsal and side series join to form rings which, however, do not cross the ventrals.

The tail has the same ground color as the body (differing from the *atrox* group and *scutulatus*). It is crossed by rings approximately equal to the interspaces and showing the following variation in number: males 5 to 8, average of 95 specimens 7.2; females 5 to 7, average of 58 specimens 5.8. The last two or three rings are usually dark brown or black, are narrow and often less evenly defined than the others, a characteristic of *confluentus*.

Below, the color is cream or straw suffused with gray. The dark areas are more evident on the edges of the ventrals and posteriorly. The underside of the tail is usually mottled with black. The base of the rattles is black.

The young of this subspecies differ less in color and markings from *oreganus* and *confluentus* than the adults.

As seems to be generally the case with rattlers, the males of this subspecies in collections exceed the females in the ratio of about 60 to 40.

THE TIGER RATTLESNAKE AND ITS AFFINITIES

When, in 1893, the Death Valley Expedition collection was worked up there seem to have been available in the National Museum only three specimens of *Crotalus tigris,* the co-types USNM 471 and 472 from Sierra Verde and USNM 5271 from Fort Buchanan, Arizona. The former were already over forty years old and in rather poor condition. The latter was a peculiar specimen, a faded skin of doubtful classification.[15] It was natural, therefore, when the Expedition brought in fourteen fine specimens from California and Nevada that certain differences of marking and form, evident in a larger series, between the northern and southern specimens should have gone unnoted. Since that time the California-Nevada specimens available have been increased by the Heller (Field Museum) collection and a number in the Museum of

15 I would classify it as *C. c. confluentus.*

Vertebrate Zoology of the University of California. But few additions have come in from Arizona, so that the California-Nevada material has quite overshadowed that from Arizona until quite recently.

Camp in 1916[16] remarked concerning three rattlers taken at Horn Mine, southeastern San Bernardino County, California: "In scutellation and coloration these examples show departure from some of the typical characteristics of *mitchellii* and seem to approach to a certain extent those of *tigris*." He was speaking primarily of the separation by small scales of the rostral and prenasal, which separation had long been considered the test for *mitchellii*.

Do Amaral,[17] in his study of *tigris* and *mitchellii* in 1929, determined that intergradation was indicated not only in this essential characteristic but in color as well. He therefore concluded that *mitchellii* is a subspecies of *tigris*, and referred to it as *Crotalus tigris mitchellii*.

From time to time in the course of extracting venom from San Diego County specimens of *mitchellii* I have noted individuals having a prenasal partly or wholly in contact with the rostral on one or both sides. A study was therefore begun on the relationship of this form with *tigris* and, from a consideration of material which has only recently become available, it was determined:

First: That the California-Nevada form of *tigris* not only intergrades with *mitchellii* as previously determined by do Amaral, but likewise intergrades with *lutosus* in west central Nevada; and,

Second: That the Arizona form of *tigris* seems to be quite distinct from the California-Nevada race.

Intergradation of the Arizona, or true *tigris*, with *mitchellii* is not evident from any available material, as is the case with the California-Nevada form. Thus the Arizona species remains *Crotalus tigris*, while the California-Nevada form becomes a subspecies of *C. confluentus* as does *mitchellii* as well.

The first conclusion particularly was a surprise to me, for an acquaintance with *mitchellii* and *oreganus* as they are found in their coincident ranges in San Diego County, California, would never have caused me to suspect so close a relationship.[18]

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16 Univ. of Calif. Pubs. in Zool., Vol. 12, No. 17, p. 533.

17 Bull. Antivenin Inst. of Am., Vol. II, No. 4, p. 82.

18 Stejneger anticipated this relationship when he studied the Death Valley series. "A study of the present series convinces me that the nearest affinity of the 'tiger rattler' is with the true *Crotalus confluentus* of the plains in spite of the rather striking and in many respects peculiar aspect of the former." N. A. Fauna, No. 7, p. 215.

In this investigation, through the kindly help of several institutions and some purchased material, I have been able to assemble 30 preserved specimens of the form hitherto considered *tigris* from California-Nevada and 12 of the true *tigris* from Arizona. I have had for comparative purposes, 52 specimens of *mitchellii.* I have seen alive several additional *tigris* from each area and about 150 specimens of *mitchellii.*

Since the California-Nevada form hitherto considered *tigris* differs both from *Crotalus confluentus lutosus,* with which it intergrades to the north, and *Crotalus confluentus mitchellii* (as the latter must now be known) to the south, it requires a new name for which I suggest

Crotalus confluentus stephensi,[19] subsp. nov.

Panamint Rattlesnake

Plate 10, fig. 2.

Type.—No. 6699 in the collection of the Museum of Vertebrate Zoology of the University of California. Collected two miles west of Jackass Springs, Panamint Mts., altitude 6200 ft., Inyo County, California, by Dr. Joseph Grinnell, October 8, 1917.

Diagnosis.—A subspecies of *Crotalus confluentus* differing from the other subspecies except *mitchellii* in markings and coloration; in lower average internasals and scale rows; in having a rostral usually wider than high; also in high proportion of indented or sutured supraoculars. From *mitchellii* it differs in having the rostral generally in contact with the prenasal. From *C. tigris* it differs in greater number of ventrals, supra- and infralabials; in markings and color; in sutured supraoculars and in larger proportionate head size.

Description of Type.—Young adult male. Length 591 to rattles, tail length 48, ratio .081. Length of head 26, times contained in body length 22.8. Width of head 20. Width across supraoculars 12.0, distance between supraoculars 4.4, ratio 2.7. The head is subtriangular, moderately depressed and, except for the supraoculars, covered with small scales. These are irregular and unkeeled except posteriorly.

The scale rows are 25-25-19, keeled except the first row. Ventrals 177, anal entire, caudals 25, supralabials 15-15, infralabials 14-15. Rostral wider than high. Two scales in contact with the rostral between prenasals; total in contact 7 including both prenasals. Prenasals in contact with first supralabials (right almost separated). Scales on top of head along canthus rostralis 4-4, the posterior larger. Scales on head anterior to supraoculars 25. Minimum scale rows between supraoculars 5. Supraoculars sutured at outer edges and of rough texture. Nasals 2-2, loreals 2-3. Postnasal not in contact with upper

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[19] Named in honor of my good friend Frank Stephens, Curator Emeritus of The San Diego Society of Natural History and a member of the Death Valley Expedition which first collected this form nearly forty years ago.

preocular. Preoculars 2-2, post- and suboculars 5-5. Partial split in right upper preocular. Scale rows between labials and orbit 2+3+4, 2+3+4. First infralabials in contact on median line; three infralabials in contact with the genials on either side. Genials in a single pair, short and with relatively obtuse terminal angles.

Above, the head is light brown mottled with darker. A supraocular cross mark is faintly in evidence on one side. Side stripes on the head are obsolete. Below the color is straw, the mental and infralabials suffused with gray.

The dorsal body pattern consists of a series of thirty-five roughly margined subhexagonal brown blotches on a drab background, tending to grayish on the sides. Punctations are in evidence in both blotches and background. The anterior and posterior bordering scales of the blotches are often tipped with black. At midbody the blotches are $2\frac{1}{2}$ to 3 scales wide (along the body) by about 11 scale rows across. The interspaces are slightly narrower than the blotches. A secondary series on the sides is quite in evidence and is of double frequency. Beginning at about blotch 17 the dorsal and half the side marks are confluent, from which point the blotches degenerate into rings. The ventrals are mottled with patches of gray dots.

The tail rings number 6, of which the terminal 2 are black, the last being wider. The interspaces are narrower than the rings. Below, the tail is mottled, the last ring only being complete on the underside.

There are 5 rattles in the string, tapering from the base, thus indicating future growth. The base is black. Probably only the button is missing.

Range.—This subspecies ranges from northwestern Esmeralda County, Nevada, and Round Valley, Mono County, California, southeasterly to Clark County, Nevada, and northern San Bernardino County, California. In southern Mineral County, Nevada, there is intergradation with *lutosus*. From near Mono Lake, California, two specimens that I have seen were pure *lutosus*. In Inyo County, California, *stephensi* occurs in the Inyo, Coso, Panamint, Argus, Black, Slate, Grapevine and Funeral Ranges. West of Owens Valley it ascends the east slope of the Sierras at least to an altitude of 6500 ft. (Independence Creek). Here intergradation with *oreganus* is possible although not indicated by present specimens. The southerly limit is difficult of definition because of the gradual intergradation with *mitchellii*. I have referred to *stephensi* specimens as far south as Randsburg and Cave Springs, San Bernardino County, while those to the south from Barstow, Turtle Mountains and near Needles, California, because of size and coloration, have been considered *mitchellii*, in spite of occasional incomplete rostral separation. In Nevada the eastern limit is imperfectly known. One specimen is available from Nye County near the state line, and three from the vicinity of Las Vegas, Clark County, which show *mitchellii* tendencies in markings and color.

General Description and Remarks.—The following is a summary of scale counts and measurements of 30 specimens.

Size medium. Scale rows at midbody 23 or 25, average 23.6. Scales are keeled, except occasionally the first or first and second rows.

Ventrals, males 166 to 181, average 174; females 173 to 182, average 178. Anal entire. Caudals, males 23 to 27, average 25; females 17 to 22, average 19. Supralabials usually 13, 14 or 15, rarely 12 or 16, average 14.3. Infralabials usually 14 to 16, rarely 17 or 18, average 15.3.

The rostral is wider than high (rarely equal) and is at least partly in contact with the prenasals. The prenasals are generally in contact with the first supralabials. There are two internasals, except in one instance in which there are four, owing to the beginning of the separation typical of *mitchellii*. The canthals vary from 2 to 5, being generally 3 or 4. Scales on top of the head anterior to the supraoculars are rarely less than 20 and average 24. (The corresponding figure for *tigris* is 16). The minimum scale rows between supraoculars are usually 5 or 6, occasionally 3, 4 or 8.

Supraocular sutures or indentations are evident in 29 cases out of 30.[20] They usually take the form of lines or circular swirls at the outer edges. The supraoculars are roughened even where they are unbroken. Occasionally the outer edge is rough, as if bits had fallen away at the sutures. The nasals are 2-2; the loreals 1 or 2, rarely 3. The upper preocular may be entire or split either vertically or at angle. The minimum scale rows from labials to orbit are 2 or 3. The first infralabials are undivided; three are usually in contact with the genials on each side.

In color this subspecies is highly variable, as if the several desert mountain ranges had produced different races. The ground color may be straw, tan, yellow-brown, buff, gray or blue-gray. The dorsal blotches are usually subhexagonal, but may approach diamonds, squares or rectangles. They vary from gray to buff, brown or red-brown and may or may not be sharply contrasting with the ground color. The edges are seldom even or clearly defined. Posteriorly the blotches deteriorate into rings. In number the blotches vary from 30 to 43, average 37. Punctations resembling those of *mitchellii* are often in evidence. Below, the color is yellow or straw mottled with gray. Specimens from the southeastern section of the range are lighter, with less pronounced blotches and are usually punctated in the *mitchellii* manner. Many specimens have characteristic black tips on the scales bordering the blotches.[21] The head is not brightly marked. The pre- and postocular light stripes are generally obsolete; where present the postocular stripe is

20 In *tigris* the count is ten negative and one doubtful out of eleven.

21 Occasionally seen also in *mitchellii* and *lutosus*.

2 scales wide and passes above the angle of the mouth. The supraocular cross mark is usually missing but is occasionally faintly in evidence.

The tail rings vary from 3 to 6 in the females (usually 5) and 6 to 8 in the males (usually 6 or 7). From 1 to 3 terminal rings are black. The ground color of the tail does not differ essentially from the body color. The base of the rattles is black.

The ratio of body length to head in adults varies from 20.2 to 24.0, the average being 22.2. The corresponding figures for *lutosus* are 19.4 to 26.3, average 22.9 and for *tigris* with its conspicuously small head 24.6 to 27.6, average 25.9. For southern California *mitchellii* the average is 21.9; for Arizona *mitchellii* 22.8.

The ratio of tail to total length except rattles is, for the males, .074 to .089, average .081, and for the females .053 to .066, average .061.

The ratio of the distance across the supraoculars to the space between varies from 2.3 to 3.3, average 2.7.

The largest specimen examined measured 840 mm., the smallest 257 mm.

A NEW SUBSPECIES FROM THE UPPER COLORADO BASIN

In the valleys of the Colorado and Green Rivers above their junction there exists a stunted, light colored form of *C. confluentus* differing materially from its neighbors on all sides. If any rattlesnake deserves to be called a "White" rattler it is this, although it is in reality cream colored. However, it is lighter than any *mitchellii* or *cerastes* that I have ever seen and specimens have even been considered albinos. For this subspecies I propose the name

Crotalus confluentus decolor,[22] subsp. nov.*

MIDGET FADED RATTLESNAKE

Type.—No. 923 in the collection of the Field Museum of Natural History. Captured at Grand Junction, Mesa County, Colorado. Collected by E. S. Riggs and H. W. Menke in the summer of 1900. Paratype: No. 922 taken at the same time and place.

Diagnosis.—A subspecies of *Crotalus confluentus* differing from all other

22 Faded; also degenerate.

* After the completion of this paper, but too late to permit its modification, I received A. M. Woodbury's paper entitled "A New Rattlesnake from Utah," Bulletin of the University of Utah, Vol. 20, No. 6, Dec. 1, 1929, in which *Crotalus concolor* from King's Ranch, Garfield County, Utah, is described. That this will probably throw *Crotalus confluentus decolor* into synonymy is evident.

subspecies in coloration and size, being the lightest as well as the smallest of the several subspecies.

Description of Type.—Adult male. Length 513 to rattles, tail length 43, ratio tail to total length .084. Length of head 23, times contained in body length 22.3. Width across supraoculars 11.6, space between 4.8, ratio 2.4. The head is subtriangular, moderately depressed and, except for the supraoculars, covered with small scales. These are practically unkeeled throughout. The canthus rostralis is sharp and the nose upturned.

The scale rows are 25-25-19, keeled except the first on each side. Ventrals 169, anal entire, caudals 25, supralabials 15-14, infralabials 16-13. The rostral is higher than wide. Three scales in contact with the rostral between prenasals; total in contact 8, including both prenasals. The prenasal is in contact with the supralabials on the left but not the right. Scales along the canthus rostralis from rostral to supraoculars 4-5, of irregular size. Scales on head anterior to supraoculars about 45. Minimum scale rows between supraoculars 5. Supraoculars striated, with two small border pits on right, one on left. Nasals 2-2, loreals 2-3. Upper preoculars, undivided, not in contact with postnasals. Preoculars 2-2, post- and suboculars 6-7. Scale rows between labials and orbit 3+3, 3+4. First infralabials undivided and in contact on median line; three infralabials in contact with genials on each side. A single pair of genials, short and with outer edges curved.

Above, the head is buff. A preocular light line is faintly in evidence and thus the supraoculars are lighter. No postocular light line is to be seen, but this may be due to the condition of the specimen. A supraocular light cross dash is faintly perceptible; it is inwardly divergent.

The body (in alcohol) is buff as to ground color. This color is due to a multiplicity of small brown dots barely visible to the naked eye. Upon this ground color is superimposed a series of 43 inconspicuous subrectangular blotches with edges faintly outlined in brown and with centers slightly darker than the ground color. These blotches have moderately even edges and in width are approximately equal to the interspaces. At midbody they measure 3 to 4 scales longitudinally by 10 scale rows across the body. A secondary series of blotches is faintly in evidence on the sides. The ventrals are immaculate and of a somewhat lighter shade than the ground color.

The tail rings number about 9, the last one only being dark. This ring is the most conspicuous mark on the body. There are 9 rattles in the string, with an indeterminate number lost. Those which remain are uniform in size, indicating that this snake has practically reached his full growth. The rattle dimensions are 7.7 mm. across by 4.2 mm. thick. The length is 18.5 mm. for 9 full exterior rings. The base of the rattles is black.

Range.—This subspecies is found in northeastern Utah, extreme western Colorado and southwestern Wyoming in the valleys of the Green and Colorado Rivers above their junction. It may also be found in the valley of the San Juan; a single specimen from that area is tentatively placed in the group although differing from the others in some particulars.

Specimens have been examined from the following localities:

Grand Junction, Mesa County, Colorado (Field Museum 923-922). *Type* and *paratype.*

Green River, Sweetwater County, Wyoming, 4 mi. north of Linwood, Utah. (USNM 48680).

White River, Uintah County, Utah (Carnegie 1429).

Dragon, Uintah County, Utah (Field Museum 2791).

East of Helper, Carbon County, Utah (Univ. Mich. 62143).

Thompson, Grand County, Utah (CAS 39098, 40960).

Grand Gulch, San Juan County, Utah (tentative) (AMNH 18104).

From within the territory bounded by these localities all *Crotalus* specimens examined have consistently fallen into this classification. Little is known as to the exact limits of the territory occupied, since specimens are not avaliable from closely contiguous points. This is not the only subspecies in Colorado west of the Rockies; I have seen specimens of typical *confluentus* from Maybell, Moffatt County, and Naturita, Montrose County, which localities are north and south of the Colorado River. The areas of intergradation remain to be determined.

General Description and Remarks.—The following are the results of an examination of the 9 specimens listed, of which two are, unfortunately, in poor condition.

Size, small. Scale rows at midbody 23 or 25, average 24.3. Scales are keeled except the first one or two rows on either side.

Ventrals, males 169 to 178, average 173; females 173 to 181, average 178. Anal entire. Caudals, males 21 to 25, average 23; females 18 to 21, average 19. Supralabials 13 to 16, average 14.3; infralabials 13 to 16, average 14.8.

The rostral is higher than wide and is in contact with the prenasals. The prenasals may be in contact with the supralabials or separated therefrom by a row of scales. The internasals vary from 2 to 5, average 3.6. The canthals vary from 2 to 4. Scales on the top of the head anterior to the supraoculars average 33. The minimum scale rows between supraoculars vary from 4 to 7, averaging 6. Supraocular indentations are evident only in the type specimen. The nasals are 2-2; the loreals 1 to 3, more often 2. The upper preocular is occasionally split; it is not in contact with the postnasal. The scale rows from labials to orbit vary from 2 to 4. One specimen has irregularly divided first infralabials. Usually 3 infralabials are in contact with the genials on each side.

The color (in alcohol) of this subspecies is chalk white, straw or cream. The ground color is partly derived from a thick sprinkling of dots which are sometimes quite conspicuous. The dorsal blotches are usually subrectangular in shape, with the long axis across the body. Occasionally they are elliptical or square. In one specimen (CAS 38098) they are quite obsolete and the specimen is unicolor. Usually the blotch centers are similar in color to the area outside with only the borders in evidence, but occasionally the centers are darker, although still in contrast with the dark brown of the edges. The edges are even, as in *confluentus,* rather than irregular, as in *lutosus.* The body blotches average 40. The color below is clear or faintly mottled. The tail rings average 8, the last one or two being generally black, constituting the most conspicuous item of the coloration.

On the head, supraocular cross dashes of the inwardly divergent type are usually present, thus resembling *confluentus.* The pre- and postocular light stripes are sometimes faintly in evidence. The posterior when apparent is 2 to 3 scales wide, thus showing affinity to *lutosus.* In body blotches and tail rings this subspecies seems more nearly to resemble *confluentus;* but the scale rows between the supraoculars and width of the postocular light line indicate affinity to *lutosus.*

The ratio of body length to head averages 23.1 (range 22.3-23.7). The ratio of tail to total length averages for the males .077 and for the females .056. The ratio of the distance across the supraoculars to the interspace is 2.5.

The largest specimen examined measures 640 mm., the smallest 451 mm., average 537 mm. That this is not a chance collection of immature specimens is clearly indicated by the character of the rattles, which are small and in most cases have reached parallelism.

This summary is based entirely on alcoholic material; I have seen none of this subspecies alive.

GRAND CANYON RATTLESNAKE

In the Grand Canyon occurs a peculiar phase of *Crotalus confluentus* distinguished by its vermilion or salmon coloration and an almost complete absence of markings in the adult. This may be known as

Crotalus confluentus abyssus,[23] subsp. nov.

GRAND CANYON RATTLESNAKE

Plate 11, fig. 1.

Type.—No. 2216 in collection of L.M.K. Captured alive on the Tanner

23 Having reference to habitat.

Trail 300 ft. below the south rim of the Grand Canyon, Coconino County, Arizona; altitude approximately 7000 ft. Collected Sept. 15, 1929, by E. D. McKee.

Diagnosis.—A large form of *Crotalus confluentus* differing from all other subspecies in coloration and in virtual absence of markings in the mature adults.

Description of Type.—Adult male. Length 905 to rattles, tail length 62, ratio of tail to total length .069. Length of head 39, times contained in body length 23.2. Width of head 32. Width across supraoculars 19.3, distance between 7.4, ratio 2.6. Head flat-topped and depressed, suboval in outline, and, except for the supraoculars, covered with small scales. Posteriorly these are keeled.

The scale rows are 25-25-19, all except the first row on each side being keeled. The ventrals are 173, anal entire, caudals 25, supralabials 17-17, infralabials 15-15. The rostral is higher than wide. Four scales in contact with the rostral between the prenasals; total in contact 8, including both prenasals. Prenasal in contact with the first supralabial on each side. Scales along the canthus rostralis from rostral to supraocular 5-5, the posterior largest. Scales on head anterior to the supraoculars about 35. Minimum scale rows between supraoculars 6. Supraoculars rough with a slight fold in evidence on each. Nasals 2-2, loreals 1-1, upper preocular not in contact with postnasal, not divided vertically. Preoculars 2-2, sub- and postoculars 6-6. Scale rows between labials and orbit 3+4, 3+4. First infralabials undivided and in contact on median line; 4-3 in contact with genials. A single pair of genials, short and with outer edges curved.

The head is fawn color above. A preocular light stripe is faintly in evidence, of orange color; the postocular stripe is obsolete. Supraocular cross mark faintly in evidence, inwardly divergent.

The ground color of the body dorsally (shortly after preservation in alcohol) was "Fawn Color"[24], on the sides "Onion-skin Pink", below "Pinkish Buff" suffused with gray. In life the dorsal color was lighter and brighter, being between "Flesh-ocher" and "Salmon Color."

When held at a proper angle with the light, a series of 42 dorsal blotches may be seen, faintly darker than the ground color—particularly the borders. These are of characteristic *confluentus* subrectangular shape and measure about 9 scales across the body by 3½ longitudinally. The interspaces are somewhat narrower. A secondary series of blotches is faintly discernible posteriorly. The tail rings number 8 of which the last two are almost black, constituting the only conspicuous marks on the body.

The rattles are an incomplete string of 12 of which at least 10 show parallel dimensions (13.3 mm. across). The base is black.

Range.—This form has been taken only in the Grand Canyon of the

[24] Quotation marks refer to color designations of Ridgway, 1912.

Colorado in the vicinity of Grand Canyon P. O., Coconino County, Arizona, but on both sides of the river and at least to the rim of the Canyon.

General Description and Remarks.—The first specimen seen of this striking form was kindly forwarded me by Mr. Vernon Bailey. Subsequently I received three live specimens through the courtesy of Mr. E. D. McKee, Naturalist at Grand Canyon National Park and his assistant Mr. S. B. Jones. Altogether I have examined the following specimens from the immediate vicinity of the Canyon (in the Park region) covering a distance of about 40 miles along the river:

Number		*Locality*	*Bank*	*Note*
GCNP	R37	Tonto Platform near Bright Angel Trail Alt. 4000 ft.	S	P
GCNP	R38	Plateau near Navajo Point, Alt. 7000 ft.	S	
GCNP	R49	Phantom Ranch, north of Bright Angel Creek	S	SK
GCNP	R50	Desert View Point	S	P
GCNP	R51	Desert View Point	S	P
LMK	2093	Roaring Springs Power Plant	N	
LMK	2215	Roaring Springs Power Plant	N	A
LMK	2216	Tanner Trail, 300 ft. below South Rim, Alt. 7000 ft. (*Type*)	S	A
LMK	2272	Grand View Trail, 2000 ft. below South Rim	S	A
USNM	32725	Grand Canyon		SK
USNM	59747	Shimuno Creek	N	SK
USNM	78477	Bright Angel Canyon	N	SK
USNM	78478	Burro Spring	N	SK

(Notes: A—Seen alive. P—Poor condition. SK—Skin. GCNP—Grand Canyon National Park Specimen.)

It will be observed that several of these specimens are in poor condition or are skins. Concerning these the evidence is by no means conclusive, as important characteristics cannot be safely determined from them. From an examination they seem neither to prove nor disprove the theory that this is a consistent subspecies with the confines of the Canyon. I have every reason to believe that *confluentus confluentus* as it ranges in north central Arizona comes quite up to the Canyon rim; I have seen specimens from Anita, Valle and points farther south. I am of the opinion that GCNP R38, R50 and R51 may be considered *confluentus confluentus* or intergrades. Of the balance all the adults show the pink or salmon coloration modified by the method of preservation used. Blotches are more or less in evidence depending on age.

With reference to the specimens examined alive, LMK 2272 is a juvenile of a coloration not differing essentially from either *confluentus* or *oreganus*. LMK 2215 is a young adult with conspicuous orange brown dorsal blotches on a salmon background. LMK 2093 (not seen alive) is similar in color to the type, of large size and with blotches even less evident.

From the 10 specimens taken within the Canyon, the following general description and variations of the form may be compiled: Size large. Scale rows 25 or 27; ventrals 173 to 191 (males 173 to 185, females 183 to 191); anal entire; caudals, males 23 to 27, females 21 or 22. Supralabials usually 15 or 16, occasionally 17; infralabials 14 to 17, usually 15 or 16. First infralabials undivided (one shows a tendency toward division). Rostral higher than wide and in contact with prenasals. Internasals 3 to 6, usually 4; canthals 2 to 4. Scales on head before supralabials 24 to 35, average 30. Minimum scale rows between supralabials 5 to 8, average 6.6. Supraoculars usually without sutures. Nasals 2-2; loreals usually 2-2, occasionally 1-1. Preoculars 2 or 3; sub- and postoculars 5 to 8.

Posterior light stripe 2 to 3 scales wide, often obsolete. Body spots 39 to 46, average 43. Tail rings 6 to 8, the last 1 to 3 darker. The body blotches, when in evidence, have serrated edges. The supraocular light cross bars, when present, may have either parallel or inwardly divergent borders.

Thus we have here a form which is not unlike either *lutosus* or *confluentus* in the juvenile state, but which later departs from both. In general it seems more closely related to *lutosus* in character of body markings, width of postocular stripe, scales before and between supraoculars and in tail rings. In color it more nearly resembles *confluentus,* especially the stunted red form found in the vicinity of Winslow, Arizona. The latter, however, is a darker, richer red with typical *confluentus* markings and scutellation. This may be a case of parallel development or intergradation down the Little Colorado River.

DIFFERENTIATION OF *C. SCUTULATUS*

It appears desirable to conclude these notes with a general survey of the subspecies of *Crotalus confluentus* with particular reference to their ranges and areas of intergradation.

As I have stated, although the studies which led to the preparation of the present paper were initiated in an endeavor to understand *scutulatus,* the data on the latter are as yet unassembled and may appear later. However, I cannot at this time summarize *confluentus* without first indicating sufficient *scutulatus* differences to clear it from the picture.

To return therefore to *scutulatus,* here was a snake, the classification of which seemed to be often based largely on geographical considerations. When from the Mojave Desert or the Antelope Valley in California it was classified as *oreganus;* when from central Arizona as *oreganus, confluentus* or *atrox;* and when from southern Arizona or Mexico as *atrox* or, rarely, as *molossus.* Yet when these several specimens are brought together they are obviously the same species, differing consistently in no characteristics. The only conclusion therefore is that either this species differs from those with which it has been combined or such species themselves are all identical; and the latter is certainly not the case as between *atrox* and the members of the *confluentus* group.

The differences between *scutulatus* and *atrox* or *confluentus* are even more evident in live specimens than preserved;[25] it must be admitted that in poorly preserved material, particularly if faded, there will be cases difficult of decision. But with live or well preserved material I have yet to see a border-line case. I have tried the experiment with a commercial dealer (they usually do not differentiate between *atrox* and *scutulatus*) of suggesting that he note certain differences in coloration, markings, head form, etc., and segregate his snakes accordingly. Nothing was said about head scales or such technical points. Out of about 100 live snakes only one mistake was made and this was corrected at once when I suggested that one snake in a cage of nine was still wrongly placed.

Possibly one difficulty in the segregation of *scutulatus* is that too much stress has been placed on the paired scutes between supraoculars. This is not a certainty in classification, for occasionally one of these two scales will be split in *scutulatus* and specimens of both *atrox* and *confluentus* are sometimes met having fewer than normal scale rows at this point. Besides, it is evident that classification on a single characteristic, between forms having coincident ranges, is merely division rather than classification. But when we note as between two such species as *atrox* and *scutulatus* a considerable number of differences in which there

25 "It sometimes happens that two animal forms when studied as museum specimens are so extremely similar as to be scarcely separable, or even not always separable with certainty, although in life they could not be confused." A. H. Clark, Scientific Monthly, Sept., 1929, p. 256.

may be some overlapping in one or two at a time, but in which the weight of the evidence is always definite, we may conclude that a real difference exists.[26] And there are always characteristics not susceptible of statistical enumeration which aid in classification; as, for instance, the evident punctations in the pattern of *atrox* as compared with *scutulatus,* the sharpness of the canthus rostralis in the latter, the texture of the head scales, etc. These alone would differentiate the two species.

Some of the tabular differences follow. Only Arizona specimens will be taken, for here the species are most often confused and have similar ranges and habitats. In California, where the two species have separate ranges, it might be thought that geographical races were indicated by such differences.

A. MINIMUM SCALE ROWS BETWEEN SUPRAOCULARS

	2	*3*	*4*	*5*	*6*	*7*
Atrox	0	18	38	23	8	1
Scutulatus	92	6	0	0	0	0

B. POSTNASAL-PREOCULAR CONTACT

(Postnasal in contact with upper preocular; or, if not in contact, such contact prevented by an upper loreal.)

	Contact or loreal	*No contact and no loreal*	*Indeterminate (borderline)*
Atrox	170	1	5
Scutulatus	8	172	8

(Two counts per snake)

C. TAIL RINGS

	All black	*Part black*
Atrox	87	0
Scutulatus	13	83

D. POSTOCULAR LIGHT STRIPE

	Intersects mouth	*Above mouth*	*Indeterminate (faded, etc.)*
Atrox	87	0	2
Scutulatus	0	81	17

E. SUPRAOCULAR DASH

	Present	*Absent*	*Indeterminate (faded, etc.)*
Atrox	72	11	6
Scutulatus	8	79	10

(Differences in totals due to incomplete records made of some specimens)

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[26] An interesting statement on the cumulative weight of overlapping characters will be found in "A Contribution to the Study of Evolution Based upon the Mexican Species of *Cnemidophorus,*" by H. Gadow, Proc. Zool. Soc. London, 1906, Vol. I, pp. 277-375, at page 319.

This appears to be a rather definite proof of the difference between *atrox* and *scutulatus*. Amongst all of these specimens there is only one which overlaps or is indeterminate in more than two characteristics. And these are by no means all of the characters in which these snakes differ. Even in ventral scale counts there is a considerable average separation as shown in the following table:

	Males				Females			
	No.	*Max.*	*Min.*	*Av.*	*No.*	*Max.*	*Min.*	*Av.*
Atrox	46	192	177	184	35	195	177	187
Scutulatus	55	184	171	177	39	192	172	180

Similarly, differences may be pointed out between *scutulatus* and Arizona *oreganus* (*cerberus?*). Again the territories of these species overlap, but here the habitats are not entirely the same. In Arizona *oreganus* is a mountain form, while *scutulatus* is largely found on the desert. However, *scutulatus* does ascend the mountains and has even been taken at an altitude of 6800 ft., while *oreganus* ranges down at least to 2000 ft. So there is some overlapping (they are known to occur together in the vicinity of Prescott) yet there seems to be no intergradation. Some differences follow:

A. MINIMUM SCALE ROWS BETWEEN SUPRAOCULARS

	2	*3*	*4*	*5*	*6*	*7*	*8*
Oreganus	0	2	4	6	4	2	2
Scutulatus	92	6	0	0	0	0	0

B. SCALES IN CONTACT WITH ROSTRAL BETWEEN PRENASALS

	2	*3*	*4*	*5*
Oreganus	0	3	14	3
Scutulatus	93	1	1[27]	0

None of these specimens overlaps in both characteristics. Another useful check is the postocular light line, which in Arizona *oreganus* is almost invariably two scales wide while in *scutulatus* it is one.

The overlapping of the ranges of *scutulatus* and *confluentus confluentus* in northern Arizona is not yet indicated except by specimens of somewhat uncertain locality. It is probable that the ranges are approximately contiguous, which would lead one naturally to expect intergradation in species having so much in common. Yet I have not thus far seen any well preserved material in which the dorsal pattern did not show the following differences: *Confluentus,* squares, rectangles,

[27] May be due to abrasion and regrowth in captivity.

hexagons or ovals with the borders cutting scales indiscriminately; *scutulatus,* diamonds or hexagons with unicolor scale borders (*i. e.,* colors following scale outlines; *cf.* Plate 9, fig. 1 and Plate 12, fig. 1).

The following are some statistical comparisons, using only Arizona specimens, as before:

A. MINIMUM SCALE ROWS BETWEEN SUPRAOCULARS

	2	*3*	*4*	*5*
Confluentus	2	29	20	3
Scutulatus	92	6	0	0

B. SCALES IN CONTACT WITH ROSTRAL BETWEEN PRENASALS

	2	*3*	*4*	*5*	*6*
Confluentus	3	13	22	13	3
Scutulatus	93	1	1	0	0

C. TAIL RINGS

MALES:	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*
Confluentus	0	0	0	0	0	3	11	13	6	2
Scutulatus	0	4	29	20	3	0	0	0	0	0
FEMALES:										
Confluentus	0	0	0	0	11	4	1	0	0	0
Scutulatus	14	20	5	0	0	0	0	0	0	0

Here again, while we have some overlapping (except in the tail rings), there are always sufficient cumulative differences so that there is never doubt in the case of well preserved specimens. For instance I have one *confluentus* (LMK 196 from Winslow, Arizona) in which the head scales show no differences from *scutulatus,* one of the possible reversions to type that seem occasionally to arise in *Crotalus.* But the pattern is clearly *confluentus* not only in color, form and arrangement, but the numbers of body blotches and tail rings are both higher than in any Arizona *scutulatus* amongst nearly 100 specimens. So there is no difficulty in classification when all differential characteristics are canvassed and the material is alive or well preserved.

I have already indicated some outstanding differences between *scutulatus* and *lutosus.*

In California, intergradation between *scutulatus* and *oreganus* might be expected in the Tehachapi Mountains northwest of Antelope Valley or the San Gabriel and San Bernardino Ranges southwest of the desert. Yet notwithstanding considerable available material no intergrades as yet have been forthcoming.

So I conclude that the specific validity of *scutulatus* is demonstrated. I do not think any form should be assumed identical with another or even conspecific without definite proof.

It may be thought that there has been inconsistency in assuming a subspecific status of *decolor* and *abyssus* while *scutulatus* is considered a full species, although actual intergrades are not more available in the former cases than the latter. But the cases differ in this: first the character differences are less in the former; and secondly the former are known from comparatively few specimens and there is an absence of material from probable areas of intergradation, while in the case of *scutulatus* such areas have been investigated and both species occur pure in overlapping territory.

It is far from my intention to suggest that this is the first paper to give adequate recognition to *scutulatus,* for such is entirely contrary to fact. While is has not usually been recognized in recent check lists and keys it has from time to time been given proper status, as for instance by Boulenger in 1896.[28] Cope in his last work treated it as a subspecies of *adamanteus* (as *atrox* was also considered).[29] Brown in his review[30] considered *scutulatus* synonymous with *atrox,* but after seeing live material revised his opinion and regarded it as a valid species.[31] Van Denburgh[32] recognized its affinity with *oreganus* rather than *atrox* and thought it possibly a subspecies. He was unfortunately supplied with inadequate material, as there are only four specimens of *scutulatus* in the California Academy of Sciences collection out of their excellent series of over 300 rattlers. Most recently do Amaral has considered *scutulatus* a "morphological variation to be met with in such forms as *atrox, confluentus* and *horridus*"[33] thus following Stejneger.[34]

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28 Cat. Snakes Brit. Museum, 2nd Ed., III, p. 575.

29 1900. Report U.S.N.M. for 1898, p. 1158.

30 1901. Proc. Acad. Nat. Sci. Phila., Vol. 53, p. 103.

31 1903. Proc. Acad. Nat. Sci. Phila., Vol. 55, p. 625.

32 1922. Occ. Papers Calif. Acad. Sci., X, p. 937.

33 Bull. Antivenin Inst. Amer., Vol. III, No. 1, p. 4.

34 Report of U.S.N.M. for 1893, pp. 438-439 and 443; 1902, Proc. U.S.N.M., Vol. 25, p. 158; also in Ditmars, 1907, The Reptile Book, p. 454.

RANGES AND RELATIONSHIPS OF SUBSPECIES OF *C. CONFLUENTUS*

For a better understanding of the relationships between the several subspecies of *confluentus* and particularly such intergraditions as are now definitely known, the map shown on page 137 has been prepared. This shows the ranges of the subspecies *C. confluentus* recognized in this paper together with the outlines of the areas covered by *scutulatus, tigris* and *atrox* in the United States.

This map is based upon approximately 1500 specimens examined, together with a few others not seen, but concerning the identity of which there could be no question.

First of all it should be emphatically stated that the blank areas on the map do not necessarily indicate the absence of *Crotalus confluentus* in the form of one or more of its subspecies. On the contrary these white areas merely show that the particular subspecies occupying the territory is as yet undetermined. One might make quite probable predictions as to the subspecies to be found in many of these areas, but it appeared advisable to base the map upon known facts. In general it can be said that some subspecies of *Crotalus confluentus* occupies all of the territory included on this map with the possible exception of the highest mountain ranges and a few desert areas in Arizona, Nevada and the Antelope Valley of California; and even in these latter one of the desert-inhabiting forms such as *stephensi, lutosus* or *mitchellii* may later be found.

Stejneger's classic paper in 1895[35] separated *confluentus* from *oreganus* (*lucifer*) as independent species and until recently this scheme has been followed in most check lists and keys. It is true that Cope in several of his papers[36] considered these as subspecies, but his differentiation was based on such characters that the ranges were interwoven and the classification could not stand. More recently do Amaral[37] has again joined *confluentus* and *oreganus* into a single species (*confluentus*) with the Great Basin subspecies *kellyi* occupying the territory between.

Stejneger's differentiation of *oreganus* and *confluentus* was based almost entirely on the width of the postocular light line and the position

[35] The Poisonous Snakes of North America. Report of U. S. National Museum for the Year Ending June 30, 1893, pp. 337-487.

[36] 1883, Proc. Acad. Nat. Sci. Phila., p. 11; 1892, Proc. U.S.N.M., Vol. XIV. p. 691; 1900, Report of U.S.N.M. for 1898, p. 1169.

[37] Bull. Antivenin Inst. Amer., Vol. II, No. 4, p. 86.

of the ocular dark band. It might be assumed that, with differences of such small character and with snakes of such wide distribution, intergradation, if occurring at all, would take place on wide frontiers. Such has in fact been stated by do Amaral, who shows intermediate forms of *confluentus* and *oreganus* in Arizona and in Mexico south of the boundary. Between his Great Basin *kellyi* and *confluentus,* do Amaral finds intermediate material in Idaho and the vicinity of Winslow, Arizona. Between *oreganus a*nd the Great Basin form, he finds intergradation or intermediate forms in the southern San Joaquin Valley in California and in southeastern Oregon.

It is only in the latter territory that I find myself substantially in agreement with do Amaral. Taking the Great Basin form, which I have called *lutosus,* and *oreganus* together as a group the demonstrated connecting links to *confluentus confluentus* are far more tenuous than might at first be supposed; and while I have finally reached the conclusion that such intergradation actually does occur through *abyssus* across the Grand Canyon, the link is so indefinite that it is not shaded on the map. I am also of the opinion that intergradation is quite likely to occur at other points, as, for instance, in northwestern Wyoming and eastern Idaho, or along the line of the Union Pacific east of Ogden into Wyoming, but there being no available material from these areas, such linkage is not as yet demonstrated.

I would caution anyone referring to the map not to jump at conclusions with reference to the intergradation of closely allied forms having abutting frontiers. Such frontiers are often explained by topographic or ecologic conditions which cannot be shown with clearness on a map, and therefore a contour or life zone map should be used in conjunction with this range map. We may have, for instance, one species inhabiting the Lower Sonoran area of a desert, while another species ranges down from the Transition area of a mountain mass into its desert foothills. A map, except one drawn to the largest scale, would indicate that these forms have a common frontier, and one not familiar with the territory or the habits of the species in question would immediately conclude, if the forms be closely related, that they intergrade and are conspecific. Such for instance would be shown by a map of the respective ranges of *atrox* and *exsul i*n Riverside, San Diego and Imperial Counties, California, for here *atrox* occupies the desert while *exsul* ranges down in the desert foothills almost to the bottom of the slope. Specimens have already shown that not more than sixteen miles separate the ranges of these two forms in western Imperial County and in all probability the distance is much less. However, no intergradation has ever been indicated, and if it does occur it is not across this small gap, but is by the way of the Cape region of Lower California and the islands of the Gulf. So, in the map attached, contiguous areas, or slightly overlapping areas, are not to be assumed as indicating intergradation. It may exist but has not been proven unless such be shown by appropriate map legend.

To what extent mountains and deserts offer barriers to the different subspecies of *confluentus* remains to be determined and quite evidently differs in the different forms. The desert is a definite barrier to *oreganus* as it occurs in southern California, yet there are virtually desert areas along the west side of the San Joaquin Valley that are inhabited by a light colored phase of this subspecies. The desert is certainly no barrier to the closely related *lutosus* and of course *mitchellii* is a typically desert species, although found as high as Transition in southern California and northern Lower California. *Oreganus,* and *confluentus* as well, in the Sierras and the Rockies respectively, appear to ascend to considerable altitudes, sufficiently high, at least, to filter through the mountain passes.

I now proceeed to a discussion of the ranges, as at present known, and the possible contacts of the several subspecies of *C. confluentus.*

Confluentus:

It has been known for many years that at least one specimen of *confluentus* has been taken west of the main body of the northern Rockies, this being USNM 16791 from Lemhi, Idaho. *Oreganus,* on its side, has crossed the Cascades, and occupies eastern Washington. The mountains of northern Idaho would probably not offer an insurmountable barrier to intergradation; they can in fact be crossed without exceeding the 5000 ft. contour. We may therefore expect that intergradation will be shown in this northern region either through *lutosus* or direct from *confluentus* to *oreganus.* Further to the south, intergradation between *confluentus* and *lutosus* is possible in the vicinity of Yellowstone National Park, although specimens from the upper end of the Snake River Valley seem to be typical *lutosus* and there is a continuous mountain barrier of about 8000 ft. or more in altitude from near Livingston, Montana, to the southerly Idaho line.

I most strongly suspect intergradation between *confluentus* and *lutosus* in southwestern Wyoming, for here the Continental Divide can be crossed over a considerable gap at 8000 ft. or slightly under, this being between the Uinta and Bear River Mountains. From this standpoint, material taken between Ogden, Utah, and Rock Springs, Wyoming, in the vicinity of Curvo, Evanston, Granger and Green River, would be of the highest interest. Such material, if intermediate, would give a definite line of intergradation from the prairie states to the coast.

With reference to intergradation between *confluentus* and *decolor,* such is rather to be assumed both from the territory and the characteristics of the subspecies, but available material permits no definite conclusion. It is known, however, from specimens previously mentioned, that rather typical *confluentus* occurs westward of the main barrier of the Rockies in Colorado, both at the headwaters of the Green (Yampa), and of a branch of the Colorado itself (Rio Dolores). Thus there may be another link between *confluentus* and *oreganus* through *decolor* and *lutosus.* Continuing south we find a strong intrusion of *confluentus* into northeastern Arizona, where it occupies the plateau area on both sides of the Little Colorado basin and probably the basin likewise. Specimens of quite typical *confluentus* have been taken as far westward as the Santa Fe's branch line to the Grand Canyon.

In the vicinity of Winslow and other points along the route of the Santa Fe westward as far as Winona, Arizona, there occurs a stunted form of *confluentus* which seems not to differ from the typical form in scutellation or markings, although it is true that there is a considerable proportion which have the postocular light stripe 1½ or even 2 scales wide. That these snakes are stunted and not merely young specimens is indicated by a relatively large series all of approximately the same size, about 550 mm. long, many of which have long strings of rattles which have reached parallelism. These *confluentus* from the Winslow area are highly variable in color, running from tan, buff or fawn, to gray, red, red-brown and dark brown. Reddish specimens appear to predominate. The markings are quite clear in the adults and consist of even, subrectangular cross blotches, usually with outlines lighter than the ground color. This stunted form might have sufficient characteristics distinguishing it from *confluentus confluentus* to warrant a subspecific designation, were it not for the fact that throughout the same territory are found occasional large specimens, usually greenish or yellowish in coloration, more nearly resembling the typical form. It seems hardly possible that these can be a separate race from the stunted form. A solution of this problem must await the accession of additional material.

To the southwest will be noted an area of overlapping with Arizona *oreganus,* which form do Amaral has considered as intermediate between *confluentus* and *oreganus.* I have been unable to verify intergradation in this area. One specimen (CAS 35237) from Oak Creek, Coconino Co., Arizona, seems to have some of the characteristics of both forms; but it is unfortunately a juvenile and these seem always to be more alike than the adults of the respective subspecies.

This investigation has been somewhat handicapped by lack of material from Mexico; the general statement may be made that the rattlers as a group will never be fully understood until large series of all indigenous species are at hand from northern and central Mexico. A few specimens of *confluentus* are available from northeastern Sonora in the region below Douglas, Arizona, but aside from showing that the species occurs in Mexico nothing of interest is developed. None of the black Arizona *oreganus* has been had from below the line, although no doubt it occurs there.* Specimens of both *atrox* and *scutulatus* are available from scattered localities far down into Mexico. Usually they are not in a good state of preservation and although indicating some possible differences from the United States material they are not sufficient in either number or quality to warrant definite statements.

The characteristics of Arizona *oreganus* are discussed more fully later.

Altogether I consider intergradation between *confluentus* and *oreganus* most definitely proven through *abyssus* and *lutosus* and it is upon this link that I base the retention of the name *confluentus oreganus* for the coast form. However, as above stated, more direct links may be demonstrated when additional material to the north is available.

Decolor: †

The relationship of this subspecies has been discussed in the description. Intergradation with either *confluentus* to the east or north or *lutosus* to the west, or both, is entirely possible.

Abyssus:

This form, known from but a few specimens, is believed to intergrade with both *lutosus* and *confluentus.*

Lutosus:

The relationships of this form to the eastward have already been

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* See note page 131.
† See note page 111.

covered. To the west, intergradation with *oreganus* is quite definitely known in the northeastern counties of California and in south central Oregon. While a common frontier is shown south of Lassen County, California, to the vicinity of Mono Lake, I have seen no specimens from along this area and do not know whether intergradation actually occurs or whether the two forms are separated by the ridge of the Sierras.

Of the north limit of *lutosus* I know practically nothing. It may extend considerably to the north of the area shown on the map, especially into northeastern Oregon, or on the other hand *oreganus* and *confluentus* may close in and occupy this territory. It is quite certain that some member of the species is found practically throughout the area. To the south likewise little is known as to the territorial limit. *Lutosus* may extend considerably to the south of the range indicated, though probably not as far as Las Vegas, Nevada. Intergradation with *stephensi* is strongly indicated at one point, as above discussed.

Stephensi:

Although I show a common frontier for *stephensi* and *oreganus* in the southern Sierras, no specimens that I have seen indicate intergradation. The ranges may or may not overlap slightly if intergradation does not occur. Southward, intergradation with *mitchellii* is over a wide area and is so gradual that an arbitrary distinction between the contact forms cannot be drawn.

Mitchellii:

Besides the above mentioned intergradation with *stephensi, mitchellii* appears to be independent. It overlaps considerably the range of *oreganus* in the mountains of southern California and northern Lower California, but here the two subspecies are quite distinct, without the remotest indication of intergradation. Intergrading has not been shown with *oreganus* in west central Arizona, but I have seen a specimen of *oreganus* from the vicinity of Nelson, Arizona, that shows in its coloration, and particularly in the punctated application of color, a certain resemblance to *mitchellii.* It is likewise known that Arizona specimens of *oreganus* have occasionally complete separation between rostral and prenasal. It is probable that *mitchellii* will ultimately be shown to range over a considerably larger area of south central Arizona than here indicated, as the habitat conditions are exactly to its liking.

Overlapping of the range of *mitchellii* with *tigris* is indicated, but I have seen no signs of intergradation, notwithstanding some likeness in markings. *Tigris* seems to be a mountain form and there may be racial differences in the groups occupying the several different mountain ranges which spot southern Arizona; but all of the specimens of *tigris* that I have seen differ from *mitchellii* quite evidently in the proportionate size of the head and likewise in the slenderness of the neck. In these characteristics *tigris* most nearly resembles *enyo,* although in other points they are quite distinct. Throughout the *confluentus* group the body form is relatively constant, as is also the proportionate head size. Only in *mitchellii* does the head appear to be more depressed than in the others, yet the proportionate size is not different.[38] Taken as a whole, therefore, it would appear that body form, porportionate head size, etc., are more fundamental than scutellation, markings, and color, from which I should judge that intergradation between *mitchellii* and *tigris* in Arizona is not to be expected.

Oreganus:

The relationships between *oreganus* and the other recognized forms have already been pointed out. Whether *oreganus,* as it exists along the Pacific coast from British Columbia to the San Pedro Martir mountains in northern Lower California, is a single subspecies I do not as yet know. I have scale counts of about 300 specimens, some of which differ from others in colors and markings, but this material is inadequate to permit a definite determination. It is true that in the southern San Joaquin Valley and, in fact, in parts of the Sacramento Valley as well, there occurs a light phase of *oreganus* which do Amaral has considered intermediate with the Great Basin form. This valley type is produced by an extension of the light area between spots and consequent reduction in the dark blotch areas. But it does not seem to have the characteristic high number of scale rows between supraoculars nor the unusually wide postocular light stripe of the Great Basin form. It is, I think, a case of parallel development rather than relationship, for with the elimination of *scutulatus* from consideration it will be noted that a high mountain barrier occupied by another subspecies separates the San Joaquin Valley specimens from *lutosus.* However, it might be that this interior valley form is an intrusion from the Klamath area by way of the Pit and Sacramento Rivers. This matter warrants further study.

In general, the southern rattlers tend toward diamonds, while those

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38 It is true that *mitchellii* in the Cape region of Lower California has a proportionately smaller head. The full significance of this has not yet been determined.

from northern California, Oregon and Washington have round and more uniformly colored blotches. But this difference is not always consistent.

Southward into Lower California, *oreganus* has been shown to range as far as San Quintin. Specimens from the San Pedro Martir mountains (Meek's *helleri*) do not seem to differ from the San Diego county specimens. Farther south there is a gap of 350 miles, part of which is desert, before the first known specimen of *enyo* is encountered. Across this area *oreganus* does not seem to have penetrated. *Enyo* might come further north as it is a semi-desert form.

Through the kindness of Mr. C. C. Lamb of the University of California, I have lately seen 8 specimens of *enyo* alive and I have likewise seen 17 additional preserved specimens. I am convinced that this is a distinct species and not a subspecies of *confluentus* as has been suggested by some authors. It is true that the markings suggest *stephensi*, but here the likeness ends. *Enyo* is a snake of distinctive form, with a small and particularly narrow head and relatively large body with slender neck. In form it most nearly resembles *tigris*, although the head is proportionately longer, so that the ratio of head length to body length is not so striking. The *enyo* head somewhat suggests *polystictus*, although I see no other resemblance.

Arizona *Oreganus* (*cerberus*?):

Last we come to the Arizona *oreganus* (Coues' *cerberus*)[39] which may be a valid subspecies. This, based on present material, seems to intergrade with no adjacent form. Its wide separation from the territory known to be occupied by the coast *oreganus* is striking, nor are any existing bridges likely to be discovered. At one point following the San Bernardino Mountains there may be a spur in the range of *oreganus* to the southeastward, but these mountains terminate in the Chocolates, which fade into desert country such as *oreganus* does not inhabit. Toward the north end of its range, *cerberus* shows no indication of affinity to *lutosus*. *Cerberus* is a peculiar snake, varying in some particulars from the coast form, but with material at hand I have been at a loss to point out consistent differential characteristics. Seen alive, the differences are quite striking, for most adult specimens of *cerberus* are dorsally jet black, the interspaces between the obsolete diamonds being

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39 The term *cerberus* is used for convenience in differentiating from the coast form, rather than as an acknowledgment of validity.

indicated by a dorsal row of groups of bright yellow scale tips. With light at the proper angle the obsolete blotches can be faintly discerned. This snake apparently has the power to change, if not its color, at least its shade, so that under different conditions of light and temperature the dorsal blotches are more or less apparent, as are also the light interspaces. The same power to change has definitely been noted in *cerastes* and in certain mountain specimens of *oreganus* from southern California and possibly in *mitchellii* as well. The effect of this power is to render determination based largely on color rather ineffectual, particularly as specimens of the black Arizona *oreganus* change greatly upon preservation in alcohol. Some of the specimens which were black in life come out the same; while others, on the contrary, turn dark gray, with a series of large black-edged dark brown blotches on the back. For a time I thought these might be different races represented by the different mountain groups in Arizona, but I now believe that the variation is more one of preservation. Of the live specimens that I have seen, with the exception of two rather peculiar specimens from the northwestern end of the range, the color in life was quite consistent. This form really merits the name Black Rattlesnake, for the large mountain specimens, except for the yellow scale tips, are jet black and are also heavily mottled with black below. As is the case with other subspecies, juveniles do not differ so much from the typical form.*

Whether this is a valid subspecies or not I am not prepared to state. I have seen to date 24 preserved specimens and a somewhat smaller number alive. The effect of preservatives considerably complicates the problem. I have seen specimens from the San Bernardino Mountains in California not differing essentially from some preserved Arizona material, but I do not know how nearly alike they were in life.

Specimens of *scutulatus* found in the vicinity of Prescott, Arizona,

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* While these notes were in press, I received, through the courtesy of F. Weinberg, three specimens of *oreganus* collected about November 27, 1929, in Sonora, some 20 miles southeast of Sasabe, Pima County, Arizona, and about 10 miles below the International Boundary. So far as I am aware, these are the first specimens definitely reported from mainland Mexico.

One adult specimen has white-edged diamonds not essentially different from the markings of those taken in higher altitudes in southern California. A second adult is all black without light markings, although the diamonds may be seen to differ slightly in shade from the ground color. The third specimen, a juvenile, is much like those found in San Diego County, California, and even has the yellow tail so characteristic of juveniles from this area.

These snakes were found in a semi-dormant condition under flat stones. *C. atrox* and *C. scutulatus* were likewise collected.

are quite as dark as southern California *oreganus,* but, as has been pointed out above, no intergradation with *cerberus* is indicated.

SUBSPECIES WITH OVERLAPPING RANGES

I realize that one aspect of the conclusions drawn in this paper will be the subject of serious question, viz., the fact that two subspecies of the same species are shown to occupy the same territory without intergradation. L. M. Huey advises me that he knows of no corresponding situation amongst the birds and mammals. Nevertheless, I see no reason why it would not be possible for a species to differentiate by degrees along a circuitous route, whereby the forms ultimately meeting might be so different as not to intermingle, but to remain pure; yet if all the links still exist there will be intergradation entirely through the series from the first form to the last, and thus all would be subspecies of a single species.

A similar condition to that which exists in *Crotalus confluentus* has already been noted by Van Denburgh in *Thamnophis. Thamnophis ordinoides elegans* intergrades with *T. o. couchii* in the Sierras in the vicinity of Yosemite Valley and Kings River. *Couchii* in turn intergrades with *T. o. hammondii,* probably in Kern County, but *hammondii* and *elegans* occupy the same territory in the San Bernardino Mountains and, as I have recently noted, in the Laguna Mountains of San Diego County, California, apparently without intergradation. As these two forms occur in the southern mountains they are entirely distinct, *elegans* having a complete vertebral stripe, while *hammondii* has none.

So, in the case of *Crotalus confluentus* we have a complete loop; *mitchellii* intergrading with *stephensi* in the northern Mohave Desert, this in turn intergrading with *lutosus* in Mineral County, Nevada, the latter intergrading with *oreganus* in northeastern California; but when *mitchellii* and *oreganus* finally come together as they do in southern California, they have differentiated to such an extent that, although the ranges overlap by many miles and the snakes are found everywhere together, there is no sign of intergradation. Only at one point is this chain even slightly weak, this being intergradation between *stephensi* and *lutosus,* which is based on relatively few specimens, and may eventually be shown to be a case of hybridization. However, against this theory may be cited the finding, in specimens of *lutosus* distant from the area of intergradation, certain *stephensi* characteristics, particularly the black scale tips and the tendency toward supraocular divisions to a more prominent degree than in other species or subspecies of the genus, except *mitchellii*. Probably this overlapping of conspecific forms is most likely to occur in regions, such as that west of the Rockies, relatively contorted both topographically and climatically.

TENTATIVE KEY TO THE SUBSPECIES OF *CROTALUS CONFLUENTUS*

1. Rostral normally separated from prenasal by small scales or granules .... *mitchellii*
   Rostral normally in contact with prenasal 2
2. Internasals two; rostral usually wider than high; supraoculars rough, pitted or sutured .... *stephensi*
   Internasals generally three or more; rostral usually higher than wide; supraoculars rarely pitted or divided 3
3. Light postocular stripe one scale wide; body blotches commonly subrectangular with even edges and often with a narrow, light border .... *confluentus*
   Light postocular stripe, if present, two or more scales wide; body blotches, if in evidence, commonly diamonds, subovals or, if rectangles, rough edged without light borders 4
4. Color straw or cream; markings faintly in evidence or obsolete; adult size smaller, usually under 650 mm .... *decolor*
   Color darker, not straw or cream; adult size larger, usually over 650 mm 5
5. Adult color vermilion or salmon; body blotches obsolete in adults .... *abyssus*
   Adult color other than vermilion or salmon; body blotches in evidence in adults or body black 6
6. Ground color lighter, usually buff or drab; body blotches usually in width little greater than the interspaces; tail stripes more numerous; secondary series of lateral blotches little in evidence; intersupraocular scale rows more numerous .... *lutosus*

Ground color darker; body blotches occupying more longitudinal space than interspaces; tail stripes less numerous; secondary series of lateral blotches plain; intersupraocular scale rows less numerous..*oreganus*

SUMMARY OF CONCLUSIONS

1. *Crotalus scutulatus* is a valid species distinguished from both *C. atrox* and *C. confluentus.*

2. The group heretofore known as *C. tigris* is composite. True *tigris* is found only in Arizona and northern Mexico. Specimens from California and Nevada previously considered *tigris* are a subspecies of *C. confluentus* and form a connecting link, causing *mitchellii* likewise to become a subspecies of *C. confluentus.*

3. The following subspecies of *C. confluentus* are recognized:

A. *Confluentus.* Prairie Rattlesnake.

B. *Decolor.* Midget Faded Rattlesnake.*

C. *Abyssus.* Grand Canyon Rattlesnake.

D. *Lutosus.* Great Basin Rattlesnake.

E. *Oreganus.* Pacific Rattlesnake.

F. *Stephensi.* Panamint Rattlesnake.

G. *Mitchellii.* Bleached Rattlesnake.

B, C, D and F are newly named in this paper.

Cerberus. Black Rattlesnake is, for the present, not recognized as a valid subspecies.

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* See note page 111.

ACKNOWLEDGMENTS

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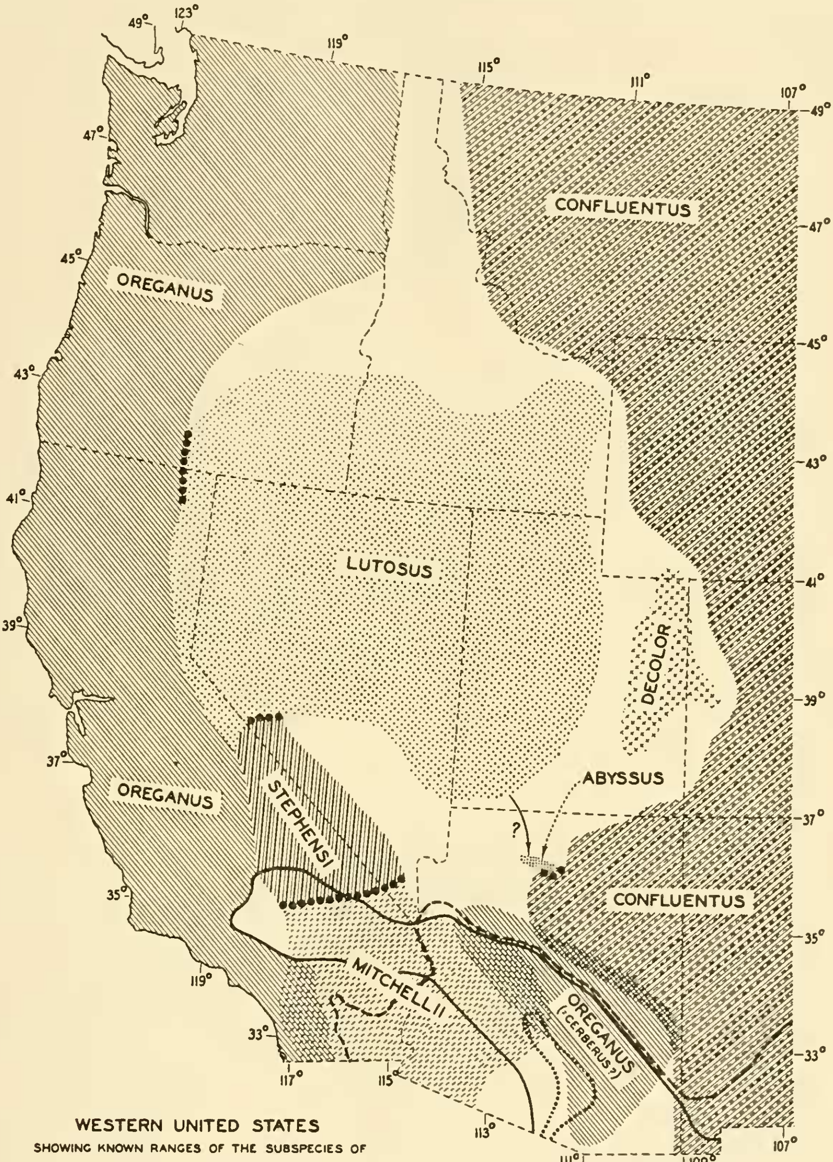
It should be understood that while this paper has been published by the San Diego Society of Natural History, Clinton G. Abbott, Director, the collections and facilities of the San Diego Zoological Society, with which I am likewise connected, have also been used, for which I am grateful to Dr. Harry Wegeforth, President, and Mrs. Belle Benchley, Executive Secretary. Photographer L. C. Kobler of the San Diego Consolidated Gas & Electric Co. is to be highly commended for his skill and patience with recalcitrant subjects.

Upon completion of this imposing list I am embarrassed by the meagre results which I have produced with such extensive assistance. My only excuse is that, to become familiar with the genus, a considerable quantity of data had to be assembled beyond the limits of the present paper, which I hope may form the basis of one or two additional reports, or, in the form of preserved material, be made available to other workers.



WESTERN UNITED STATES
SHOWING KNOWN RANGES OF THE SUBSPECIES OF
CROTALUS CONFLUENTUS
AND ALLIED FORMS

●●●●●● Known Area of Intergradation
——— C. scutulatus range limit
– – – – C. atrox range limit
·········· C. tigris range limit

NOTE: Blank areas usually indicate lack of data as to proper subspecies rather than actual absence of the species.

PLATE 9

Fig. 1. *Crotalus confluentus confluentus.* Prairie Rattlesnake.
LMK 2266. Adult male. Collected near Jetmore, Hodgeman Co., Kansas, Sept., 1929.

Fig. 2. *Crotalus confluentus oreganus.* Pacific Rattlesnake.
LMK 1887. Young adult male. Collected near Wenatchee, Chelan Co., Washington, June, 1929.

(Note: All photographs are of live specimens)

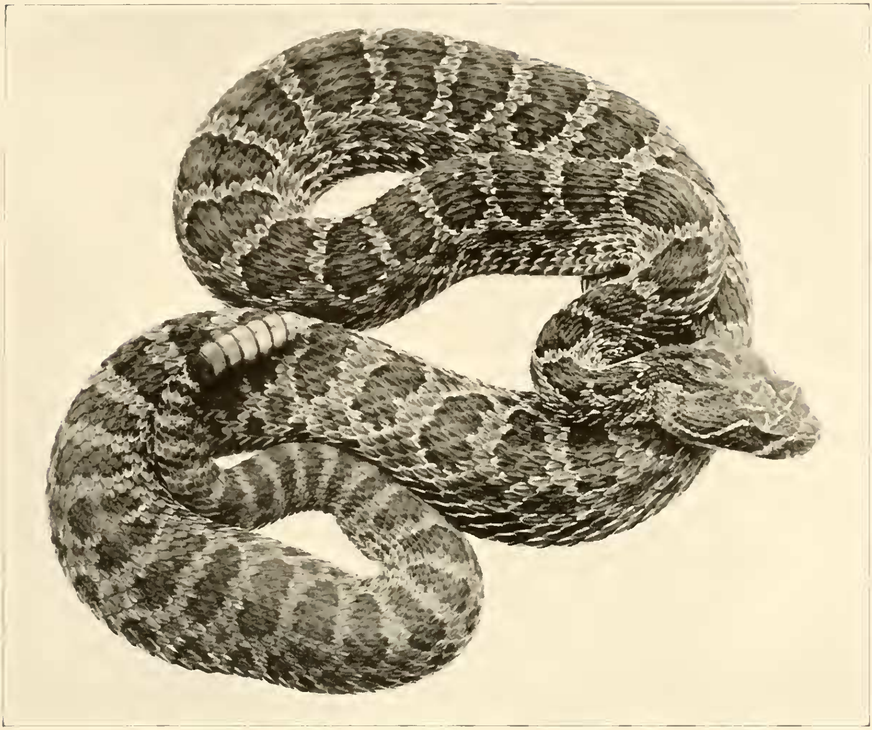


Fig. 1

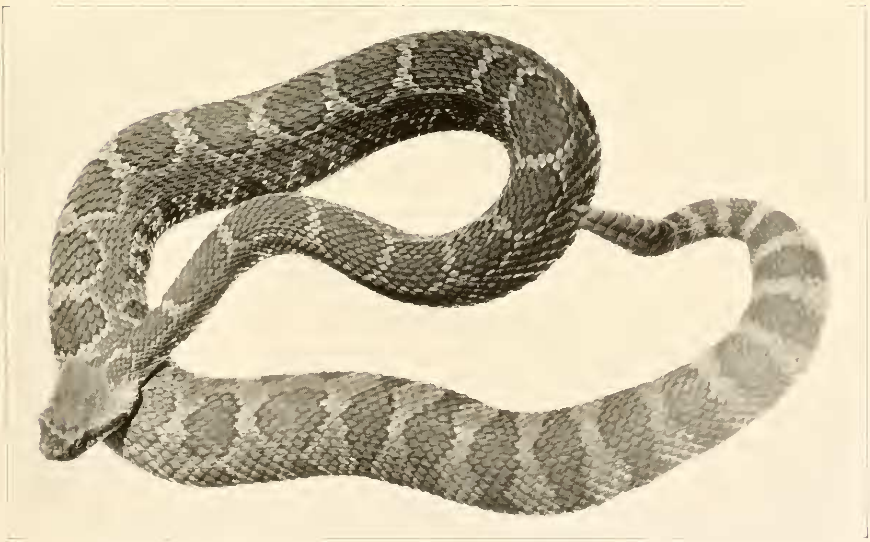


Fig. 2

PLATE 10

Fig. 1. *Crotalus confluentus lutosus.* Great Basin Rattlesnake.
LMK 1618. Adult male. Collected 5 mi. N. of Delta, Millard Co., Utah, Oct. 1928.

Fig. 2. *Crotalus confluentus stephensi.* Panamint Rattlesnake.
LMK 2115. Adult male. Collected 2 mi. S. of Aberdeen, Inyo Co., California, July 11, 1929.

Fig. 1

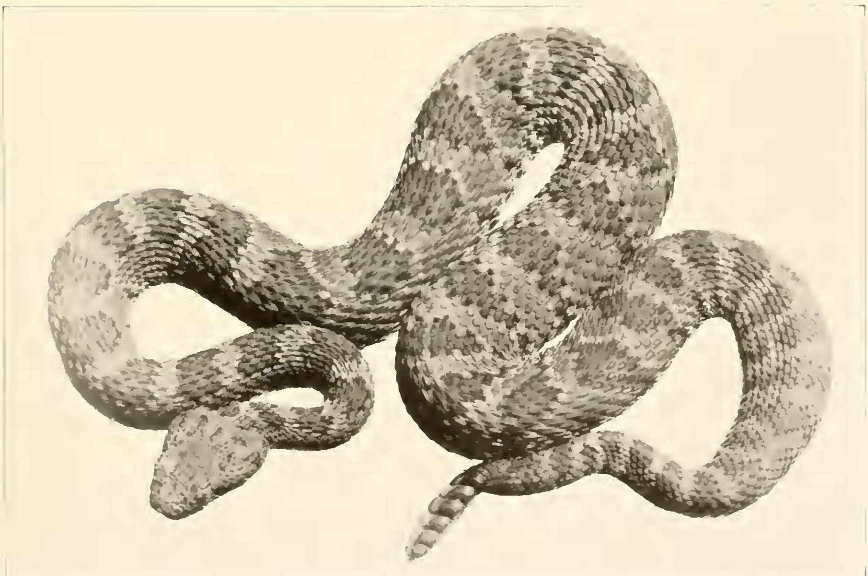


Fig. 2